REMARKS

Claims 1-13 are pending and stand rejected. Additionally, the Examiner objected to claims 1-13 as being in improper form because each of a plurality of elements or steps in the claims, as originally submitted, was not separated by a line indentation. In response to the Examiner's objection, claims 1, 4, 7, and 10 have been amended to provide line indentations for each of the plurality of elements.

The Examiner rejected claims 1-6 and 10-13 under 35 U.S.C. 103 as being obvious over Brown (US 3,358,938) in view of Wilson (US 3,145,935), Hayatdavoudi (US 4,670,161), and Eryurek et al. (US 6,601,005). The Examiner cited Brown for disclosing the use of a vibration sensor in a hydrocyclone to control the diameter of the apex and the density or the pressure of the cyclone feed; Wilson for a flow-meter sensor mounted directly on the splash skirt; Hayatdavoudi for placing sensors on a splash skirt to assist in the monitoring and control of the operation of a cyclone; and Eryurek for teaching the use of ultrasonic sensors to monitor fluid flow.

The present invention is based on the realization that the change in the angle of the underflow impacting on the skirt of a hydrocyclone as roping is about to occur is accompanied by a corresponding measurable change in the vibrations of the skirt. Further, the inventor realized that the change in vibration is repeatable and quantifiable, so that it can be compared to a set-point to track and control the condition of the underflow to avoid roping. An ultrasonic sensor is used as the preferred sensor to detect changes in the vibration of the skirt.

None of the referenced patents contemplates the problem of roping or suggests anything that would motivate one skilled in the art to monitor vibrations (or even sound) at the splash skirt as a mean to control roping. Brown teaches monitoring the exterior sound (not the vibration) of a grinding mill (not a cyclone) to monitor the hardness of the material entering the mill and slow the particulate input as needed to maintain a relatively consistent particle size (col. 5, lines 53-57). With reference to a cyclone (Fig. 3), density and viscosity are measured (in the overflow, not the underflow) to control the size of the apex opening and the density or pressure of the cyclone feed in order to vary the point at which the separation in the cyclone is made (col. 5, lines 64-72).

In essence, Brown teaches that the size of solid particles of mineral matter can be controlled quickly and accurately by employing a signal that varies according to the viscosity of a slurry of the particles (col. 1, lines 53-58). None of this has anything to do with roping in a cyclone or with monitoring an operating parameter on the splash skirt of the cyclone. Therefore, it is respectfully submitted that the concept of the invention is new and nothing in Brown would suggest or motivate one skilled in the art to use a vibration sensor in the splash skirt of the cyclone to detect the imminence of roping.

Similarly, neither Wilson, Hayatdavoudi or Eryurek disclose the use of a sensor, any sensor, in the splash skirt of a hydrocyclone to measure the degree of roping occurring in the underflow. Each of these patents is cumulative in the generic teaching of the use of various sensors to control various operating parameters of process systems. None of them deals with a sensor "mounted on the splash skirt" of a hydrocyclone, or with the problem of "detecting a change in the discharge indicative of roping," as claimed by the applicants. Therefore, each of these patents, either alone or in combination, does not add anything to the teachings of Brown that would suggest the

present invention, or motivate one to solve the problem addressed by the invention.

It is noted that the functional language recited in the applicants' claims, while not relevant as a structural limitation of apparatus claims, is nonetheless relevant to the issue of obviousness in view of the prior art. The applicants did not only place a vibration sensor on the splash skirt of a hydrocyclone, the new structural limitation, but they also did it for a purpose (detecting roping) never before considered or even indirectly suggested by anyone in the prior art.

The Examiner also rejected claims 1, 2, 4, 5, 7, 8, 10 and 12 under 35 U.S.C. 103(a) as being unpatentable over Wright et al. (US 2,648,433) in view of Hayatdavoudi and Eryurek. Wright teaches a method for preventing roping in a cyclone by sensing the pressure in the central air column in the vortex inside the cyclone. The patent does not mention using any sensor on the splash skirt of the cyclone, nor the use of a vibration sensor for any purpose. It is merely a prior-art roping-control approach which, but for the common objective, has nothing in common with the present invention in terms of approach or structural components. Therefore, combining the teachings of

Wright with those of Hayatdavoudi and Eryurek still does not teach or suggest in any way mounting a vibration sensor on the splash skirt of a hydrocyclone to detect the onset of roping.

The Examiner further rejected dependent claims 3, 6, 9, 11 and 13 under 35 U.S. C 103(a) as being unpatentable over Wright in view of Hayatdavoudi and Eryurek as applied to claims 1, 2, 4, 5, 7, 8, 10 and 12, and further in view of Brown ('938). The Examiner cited Brown for producing an output signal relative to a baseline threshold indicative of a condition of the discharge of the mill (col. 4, lines 58-61). The applicants agree with this citation, but, in view of the distinguishing limitations discussed above with reference to the related independent claims, it is submitted that these claims also recite patentable subject matter.

New claims 14-22 have been added to set forth additional novel features of the invention. Specifically, they recite an underflow discharge possessing a cone angle and a vibration sensor mounted on the splash skirt to produce a signal indicative of the cone angle of the underflow discharge.

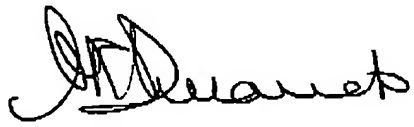
In view of the foregoing, the applicants believe that all

pending claims, as amended, recite allowable subject matter and respectfully request reconsideration of the rejection.

The applicants and their attorney thank the Examiner for the extensive search and examination of the application.

A fee of $425 is believed to be due for the additional claims submitted with this response (a total of 22 claims, six independent claims). Please charge any additional fee related to this filing to our Deposit Account No. 17-0055.

Respectfully submitted,



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